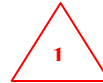


MOTT CORPORATION
INSTALLATION, OPERATION & MAINTENANCE MANUAL
FOR
EFFLUENT GAS FILTER TAG Nos. 12-F-13321 & 12-F-14321

MOTT DOCUMENT NUMBER: MIOM-2010865

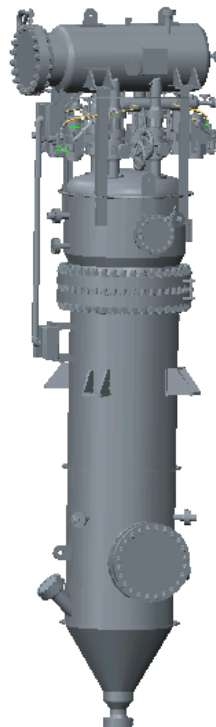
Revision 1



Pages No. 1-18

Issue Date: 04/08/15 EFM

Final revision of IOM shall include individual IOM manuals and catalogue cut sheets fro all subcomponents and ancillary equipment.



AW – PROCEED / WITH COMMENTS

FLUOR

Authorization to proceed does not relieve Contractor/Supplier of its responsibility or liability under the Contract and or Purchase Order.
By Jeremiah Telado on Apr 13, 2015

FLUOR

DOC. NO.

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REC'D: 13-APR-2015

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EQUIP/TAG NUMBER

12-F-13321

12-F-14321

Prepared For:

REC Solar Grade Silicon, LLC

REC SILICON REACTOR 25/26 PROJECT, MOSES LAKE, WA

REC SILICON PO # A5KM-4-0701-01/A5KM100004 & CO # 2 dated 17-Mar-2015



PREFACE

Catalogue Cut Sheets of sub-assembly components and ancillary equipment associated with the two Control Panels (12-F-13321-LP & 12-F-14321-LP) and two sets of Junction Boxes (12-JE-1381 / 1382 & 12-JE-1481 / 1482) will be provided in a separate stand-alone document at a later date.



TECHNICAL REFERENCE LIST

Mott Filter Vessel Specification For Customer: MFVSC # 12-F-13321 / 14321, Shts. # 1-2 of 2;
Mott Process & Instrumentation Diagram (P&ID): Drawing # D-400865, Sht. # 1 of 1;
Mott Functional Specification & Control Write-Up: MFS-2010865, Pages # 1-25 of 25;
Mott Effluent Gas Filter General Arrangement: Drawing # D-9354100, Shts. # 1-3 of 3;
Mott Auto & Manual Backpulse Valve Specification: MBPVS-12-F-13321 / 14321, Sht. # 1 of 1



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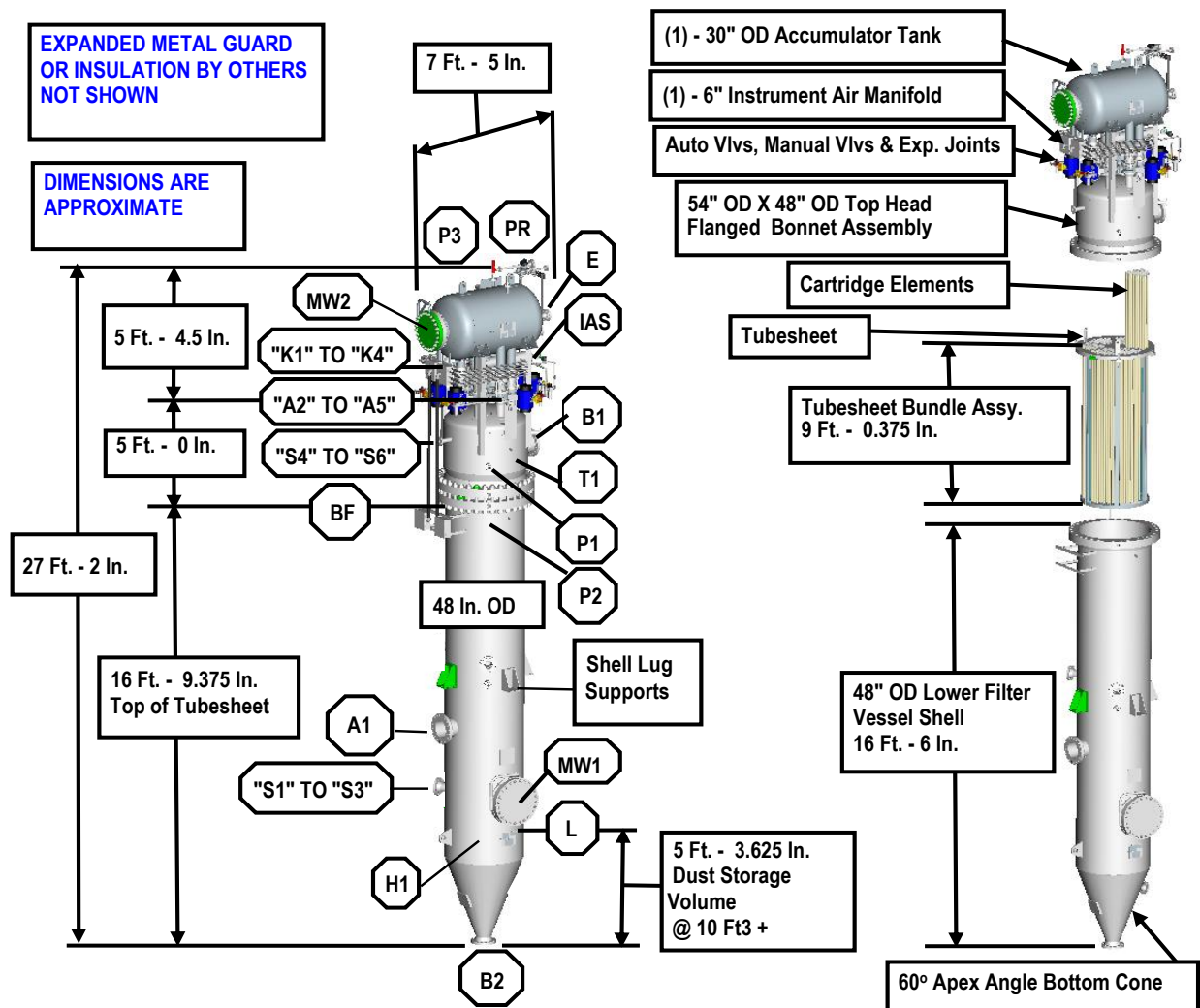
1.0 Mott GSV Down-Flow Filter Vessel System Assembly Overview

Mott is providing quantity (2) - 54" x 48" OD Effluent Gas Filter Systems Tag # 12-F-13321 & Tag # 12-F-14321 for installation (by Customer) for the REC Silicon Reactor 25/26 Project in Moses Lake, WA.

The Effluent Gas Filters remove and recover Silicon Dust Fines from a hot effluent hydrogen gas stream being discharged from Cyclone Separators downstream of Reactors in the FBR Building. Each Effluent Filter has an Automatic On-Line Cleaning System which is controlled by either a PLC based local control panel provided by Mott (12-F-13321-LP & 12-F-14321-LP) or by the Plant DCS.

Each Effluent Gas Filter System utilizes the Mott GSV Down-Flow Design Configuration in conjunction with Mott's On-Line Venturi Backpulse Cleaning System. Each Effluent Gas Filter is composed of a Filter Vessel, a Tubesheet Bundle Frame Assembly, Mott Cartridge Filter Elements, an accumulator tank, auto and manual backpulse valves, expansion joints, instrument air pipe manifold, instrument air piping, wiring, junction boxes and conduit all pre-assembled and attached to the Filter Vessel by Mott.

Figure No. 1.1: Mott GSV Down-Flow Filter Vessel System Assembly



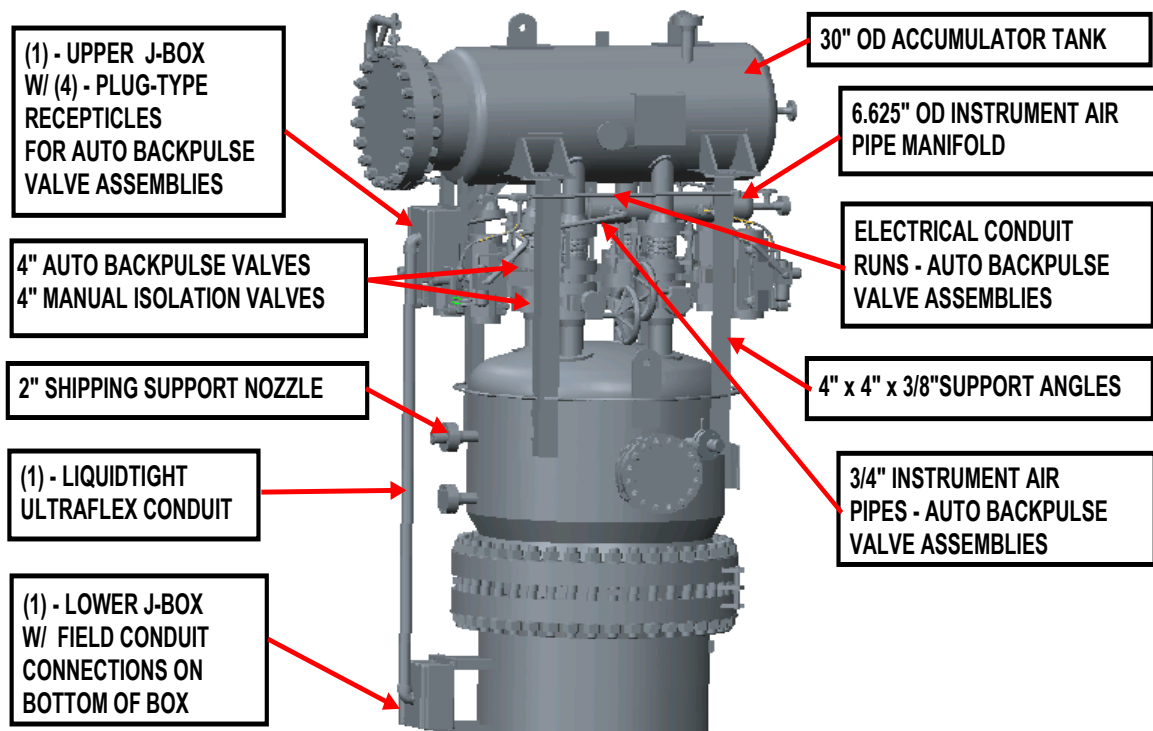
1.0 Mott GSV Down-Flow Filter Vessel System Assembly Overview - Cont'd

Each Effluent Gas Filter Vessel consists of a 54" x 48" OD Class 150 flanged top head bonnet, a 48" OD Class 150 flanged lower shell with bottom cone and a tubesheet bundle frame assembly equipped with Mott Cartridge Filter Elements. The Tubesheet Bundle Frame Assembly contains (124) - Mott MG-2 TP304L SS sintered porous metal cartridge filter elements which provide for a total filtration surface area of 676 Ft². The filter cartridge elements are 2.5 Inch OD x 100 Inch PL (porous length) with 2-1/2 Inch NPT Nitronics 60 open end venturi adapters threaded into holes through the top side of the Tubesheet. Each Effluent Filter Vessel, each Tubesheet Bundle Frame Assembly, each Accumulator Tank and each Instrument Air Pipe Manifold are all constructed of TP304/304L Dual Rated Stainless Steel material.

Each Effluent Filter has an internal radial segmented design which divides the filter vessel into four equal chambers. Mott installs vertical separator plates and distributors on the underside of the Tubesheet Bundle Frame so that the gas flow is evenly distributed in each chamber. An equal number of filter elements are contained in each segmented chamber. This radial segmented design with separator plates provides internal barriers for dust control and restricts blowback dust from contacting filter elements in adjacent chambers during on-line cleaning cycles. This Mott design provides for superior cleaning system efficiency which increases the time between element change-outs and which reduces backpulse gas consumption.



Figure No. 1.2: Mott GSV Filter Vessel Top Head Bonnet & Accumulator Tank



1.0 Mott GSV Down-Flow Filter Vessel System Assembly Overview - Cont'd

Each Effluent Gas Filter System consists of the following:

- Quantity (1) - 54" x 48" OD Class 300 TP 304/304L SS Filter Vessel with Body Flanges & Cone Bottom;
- Quantity (1) - Tubesheet Bundle Frame Assembly with 124 - 2-1/2" NPT Mott Cartridge Filter Elements;
- Quantity (1) - 30" OD Class 150 TP 304/304L SS Accumulator Tank for storage of backpulse gas;
- Quantity (1) - 6.625" OD Class 150 TP 304/304L SS Inst. Air Manifold & Piping to each Valve Actuator;
- Quantity (1) - Local Control Panel (either 12-F-13321-LP or 12-F-14321-LP);
- Quantity (4) - 4" Class 300 TP316 SS Flanged Fast Acting Auto Backpulse Valve Assemblies;
- Quantity (4) - 4" Class 300 TP316 SS Flanged Manual Gear Operated Backpulse Isolation Valves;
- Quantity (4) - 4" Class 300 TP321 SS Flanged Tied Expansion Joints;
- Quantity (2) - Junction Boxes including wiring, conduit & cabling;

2.0 Mott GSV Down-Flow Filter System Design & Process Filtration

The inlet process feed gas stream (dirty dust laden effluent gas) enters each Effluent Filter Vessel through 10" Nozzle "A1" and is evenly distributed into the four vertical filter chambers and flows downward parallel to the outside surface of the vertical cartridge elements. The process feed gas (dirty dust laden effluent gas) passes through the porous metal media of each filter cartridge element while dust solids are captured on the outside surface of the cartridge elements. The clean filtered effluent gas stream flows upward through the inside annulus of the filter cartridge elements and through the associated tubesheet holes and into the top head bonnet of each filter vessel. The clean filtered effluent gas exits the Effluent Filter Top Head Bonnet through 10" nozzle "B1".

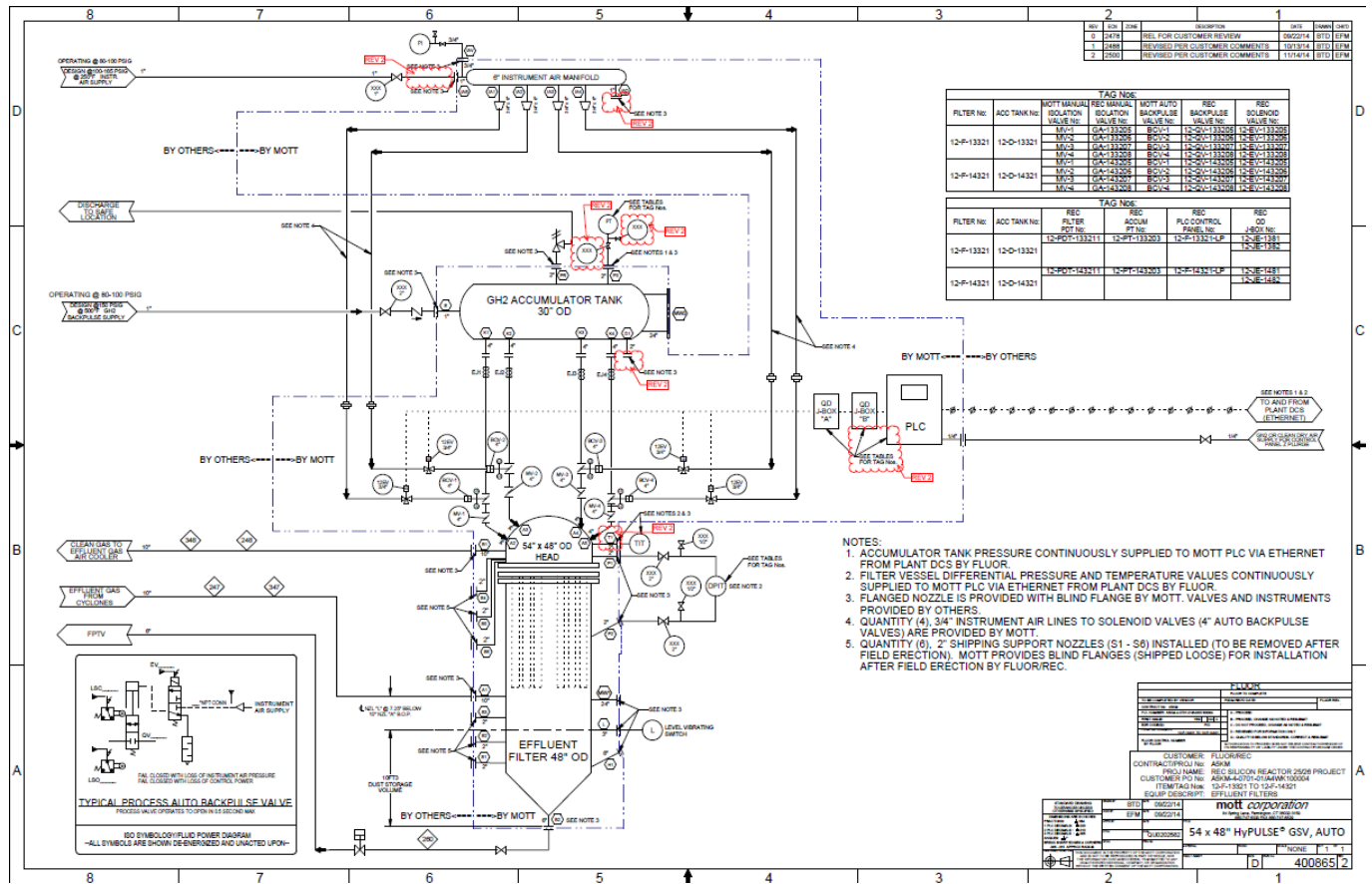
Differential Pressure (pressure drop) across each Effluent Filter is measured continuously and the process feed gas flow to each Effluent Filter is continuous. Periodically, during filtration, an on-line backpulse cleaning cycle is performed to dislodge dust cake (collected solids) from the outside surface of the filter cartridge elements.

The process feed gas stream for each Effluent Filter is either Hot Hydrogen Effluent Gas at 750 degrees Fahrenheit for Cases # 1B, 4A, 4B & 2H or it is Hot Nitrogen Gas at 950 degrees Fahrenheit for Case # 2N. The inlet process feed gas stream is laden with Silicon Dust at a dust solids concentration as follows: 2.73 Grains/Aft³ for Case # 1B, 4.26 Grains/Aft³ for Case #4A, 5.07 Grains/Aft³ for Case # 4B and 0 Grains/Aft³ for Cases # 2H & 2N. The feed gas volumetric flow rate for each Effluent Filter varies as follows: 1798 Aft³/Min for Case # 1B, 1652 Aft³/Min for Case # 4A, 1811 Aft³/Min for Case # 4B, 1968 Aft³/Min for Case # 2H and 869 Aft³/Min for Case # 2N.

The process feed gas operating pressure at the inlet of each Effluent Filter is 4.8 psig. The silicon dust solids mass flow rate varies from 42 Lb/Hr (Case # 1B) to 60.3 Lb/Hr (Case # 4A) to 78.7 Lb/Hr (Case # 4B) to 0 Lb/Hr (Cases # 2H & 2N). Silicon dust is removed from the feed gas stream as it passes through the Effluent Filter. During each on-line cleaning cycle, the Silicon Dust is discharged from the outside surface of the cartridge filter elements and is forced downward into the bottom shell and cone sections of the Effluent Filter Vessel. The dust solids are forced downward by means of gravity and by means of the downward momentum produced by the inlet down-flow of unfiltered effluent gas inside the Effluent Filter Vessel. The bottom of each Effluent Filter Vessel has been provided with 10 Ft³ of dust solids storage volume and a 6" solids outlet nozzle "B2".

2.0 Mott GSV Down-Flow Filter System Design & Process Filtration - Cont'd

Figure No. 2.1: Process & Instrumentation Diagram: Effluent Gas Filter Systems



3.0 Mott GSV Down-Flow Filter Vessel Automatic On-Line Cleaning System

The Mott automatic backpulse cleaning system provides for on-line cleaning of each Effluent Gas Filter. Each Effluent Filter cleaning system consists of the following components: (4) - 4" flanged expansion joints, (4) - 4" flanged fast acting auto backpulse valve assemblies, (4) - 4" flanged manual gear operated isolation backpulse valves, backpulse gas injection nozzles, backpulse gas venturis, instrument air pipe manifold, instrument air piping, wiring, conduit and junction boxes.

Each Effluent Gas Filter is equipped with a Customer installed differential pressure transmitter to continuously measure **differential pressure** across each filter vessel. When **differential pressure** reaches the set point (default set point is initially set at 0.35 psi) or whenever the filtration **Run Time** exceeds the set point (default set point is initially set at 210 minutes or 3.5 hours); then, an automatic on-line cleaning cycle is initiated.

3.0 Mott GSV Down-Flow Filter Vessel Automatic On-Line Cleaning System - Cont'd

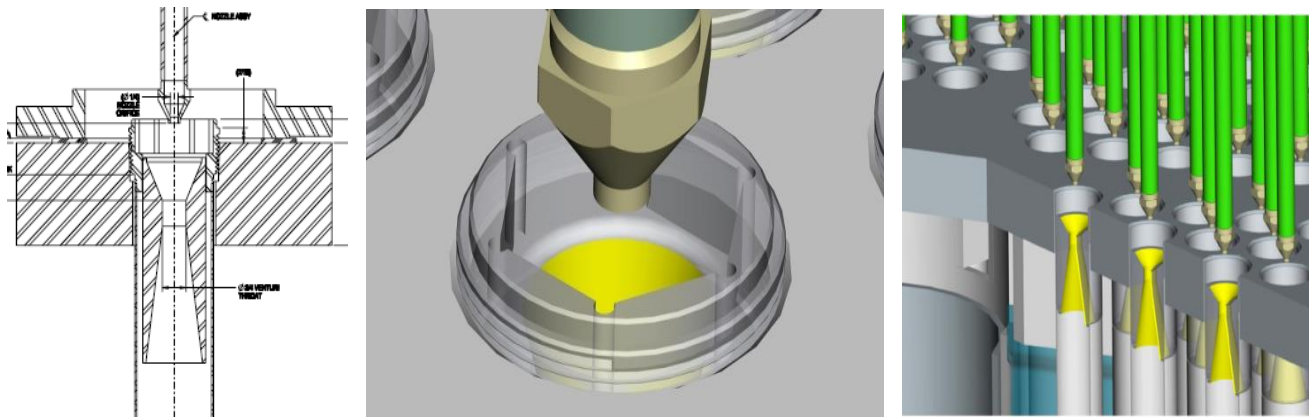
The source of backpulse gas for each Effluent Gas Filter is clean dry hydrogen gas from Accumulator Tanks 12-D-13321 & 12-D-14321 operating at a plant supply pressure of 80 to 100 psig and at a temperature of 32 to 120 degrees Fahrenheit. The plant supply of 80 to 100 psig hydrogen gas re-pressurizes the accumulator tanks during the on-line cleaning cycles. Each accumulator tank is equipped with a Customer installed **pressure transmitter** to continuously measure the backpulse gas pressure inside the accumulator tank. Each 30" OD Accumulator Tank (Mott provides one Accumulator Tank for each Effluent Filter) is close-coupled and mounted horizontally to the top of each Effluent Gas Filter Vessel.

During an on-line cleaning cycle, the four auto backpulse valve assemblies sequentially supply backpulse gas to each segmented chamber inside the Effluent Gas Filter Vessel. These four auto backpulse valves are Velan Model # F12-1BE13-DCJX-B 4" Class 300, Flanged, TP316 (CF8M) SS, Metal Seated, Butterfly Valves with single acting fail closed (spring-to-close) actuators, solenoid valves (with manual override), limit switches, position indicators, air relays, quick exhaust valves, check valves and instrument air inlet filter/regulator sets. Each auto backpulse valve assembly is fast acting and cycles from Full Closed - To - Full Open - Back To - Full Closed in less than one second (**Total Pulse Time per Valve**).

Each 6" NPS TP304/304L SS instrument air (IA) pipe manifold (provided by Mott) is located on the top head centerline of each Effluent Gas Filter Vessel just beneath the horizontal accumulator tank. This 6" NPS Instrument Air (IA) pipe manifold supplies clean dry instrument air at a plant supply pressure of 80 to 100 psig to the inlet of each filter/regulator set, solenoid valve and actuator on each auto backpulse valve assembly.

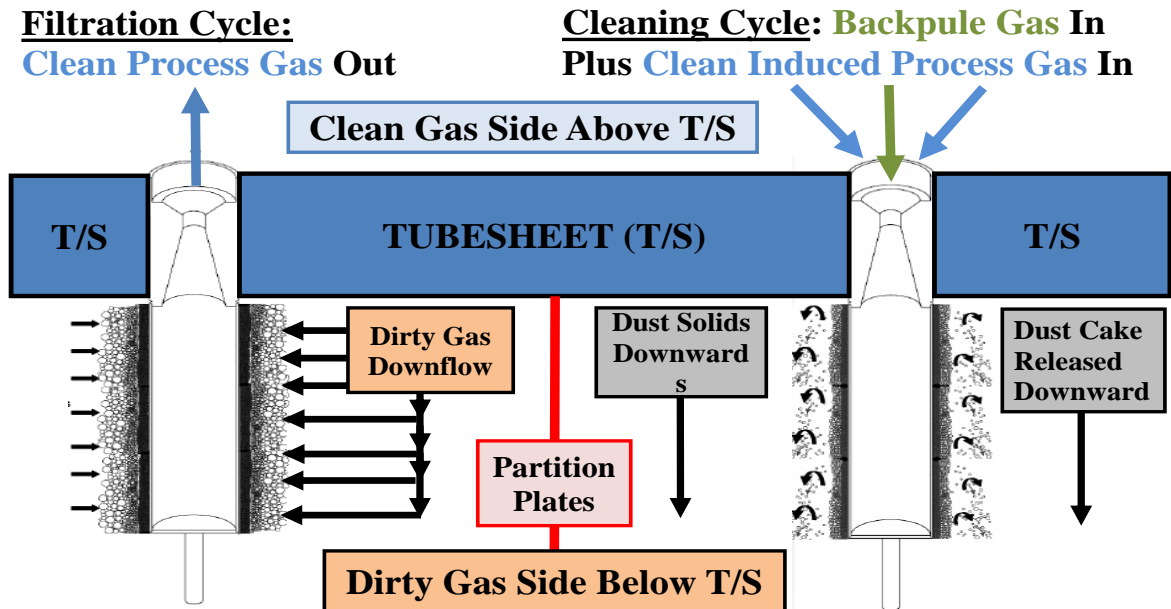
The Mott segmented chamber design in the filter vessel enables the on-line backpulse cleaning of one filter chamber while the remaining three chambers are in-service and filtering the process gas. This segmented chamber design provides dust control management during on-line cleaning cycles.

Figure No. 3.1: Typical Backpulse Gas Injection Nozzles & Cartridge Elements (Open End Venturi Adapters Threaded into Top of Tubesheet of Effluent Gas Filters)



3.0 Mott GSV Down-Flow Filter Vessel Automatic On-Line Cleaning System - Cont'd

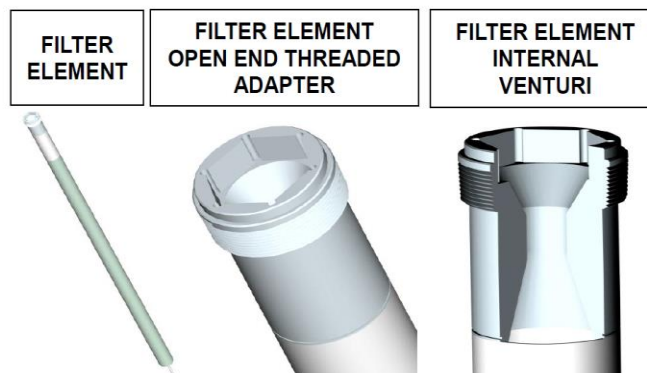
Figure No. 3.2: On-Line Cleaning System Conceptual Schematic: Effluent Filters



4.0 Mott GSV Down-Flow Filter Vessel Assembly & Components

Periodically, the operating set of cartridge elements will require removal for external cleaning. During such occasions, the operating bundle frame assembly is removed from the Filter Vessel and replaced with the spare bundle frame assembly. Bundle Frame replacement can be accomplished in less than one day. The dirty elements are removed from the old Bundle Frame and sent to an outside Cleaning Vendor. Turnaround time to clean a batch of dirty fouled elements varies from 4-6 weeks. This Mott Manual contains a list of International Cleaning Companies that are recommended by Mott for external cleaning of cartridge elements. The Bubble Point of cleaned elements should match Bubble Point of new elements

Figure No. 4.1: Mott GSV Filter Cartridge Elements



4.0 Mott GSV Down-Flow Filter Vessel Assembly & Components - Cont'd

Figure No. 4.2: Mott GSV Filter Vessel Typical Bundle Frame Assembly

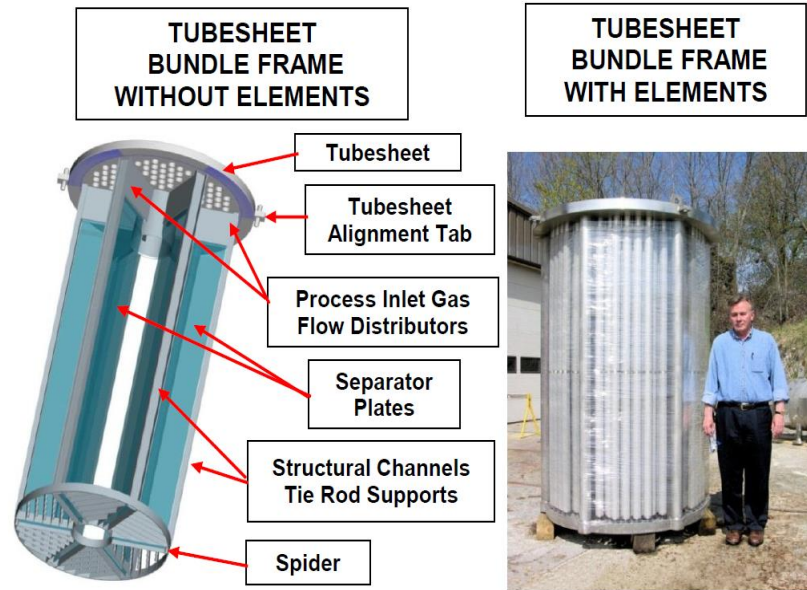


Figure No. 4.3: Typical Bundle Frame Replacement & Top Head Bonnet Removal



4.0 Mott GSV Down-Flow Filter Vessel Assembly & Components - Cont'd

Each Effluent Gas Filter Vessel is equipped with two 48" TP304/304L SS Class 300 RFWN B16.47 Series B Body Flanges for the removal of the top head bonnet assembly and for the removal of the tubesheet bundle frame assembly. The top head bonnet is lifted and removed from the filter vessel shell by using the two lifting lugs on the top of the accumulator tank. The tubesheet bundle frame is lifted and removed from the filter vessel shell by using the lifting lugs on the top side of the tubesheet.

Each Effluent Gas Filter Vessel is also equipped with a Special Upper Junction Box attached to the top head bonnet assembly (attached to the bottom of each Accumulator Tank). Each Special Upper Junction Box (Junction Box 12-JE-1381 for Effluent Filter 12-F-13321 & Junction Box 12-JE-1481 for Effluent Filter 12-F-14321) is NEMA-4X Stn. Stl. and is provided with "plugged" terminal strips and removable front cover. Each Special Upper Junction Box on each Effluent Gas Filter Top Head Bonnet Assembly provides for quick disconnect and re-connect of wire terminations during Bundle Frame & Cartridge Element removal & replacement. Each Special Upper Junction Box has four plugs (six conductors per plug). Please refer to Figures No. 4.4 & 4.5 below.

Figure No. 4.4: Typical Top Head Bonnet Removal w/ Quick Disconnect J-Box



4.0 Mott GSV Down-Flow Filter Vessel Assembly & Components - Cont'd

Figure No. 4.5: Typical Quick Disconnect Upper Junction Box Arrangement

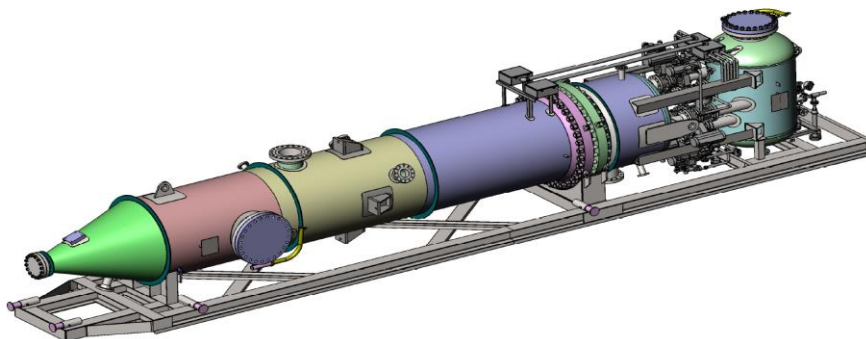


5.0 Mott GSV Down-Flow Filter Vessel: Assembled For Shipment & Lift

Before removing each Effluent Gas Filter Vessel from its respective horizontal shipping support frame, the filter vessel must be vented and depressurized. Each of the Effluent Gas Filter Vessels has been pressurized with 0.25 psig nitrogen gas to maintain cleanliness and dryness of internal surfaces. Mott has provided a pressure gauge and manual depressurization valve on the front of each Effluent Filter Vessel and each Accumulator Tank. These two manual vent valves should be opened to safely depressurize each Effluent Filter Vessel and Accumulator Tank and vent the 0.25 psig nitrogen gas to atmosphere.

Nitrogen Gas is an asphyxiant. No one should enter the Effluent Filter Vessels 12-F-13321 & 12-F-14321 thru 24" Manways MW1 until after the filter vessels have been vented and purged with air. The filter vessels still contain Nitrogen Gas at 0 psig after depressurization and Nitrogen Gas is an asphyxiant.

Figure No. 5.1: Mott GSV Filter Vessel on Horizontal Shipping Support Frame



5.0 Mott GSV Down-Flow Filter Vessel: Assembled For Shipment & Lift - Cont'd

Figure No. 5.2: Mott GSV Filter Vessel: Assembled For Shipment & Lift



Each Effluent Gas Filter is being provided as a complete assembly and is being transported and shipped on a horizontal structural skid frame. Each Effluent Filter Vessel is equipped with Special Shipping Support Nozzles to support internal filter vessel components during shipment and transport as shown in Figure No. 5.3 below. The three 2” Flanged Shipping Support Nozzles “S1”, “S2” and “S3” are located on the lower shell section of each filter vessel and provide support for the internal Bundle Frame Assembly during shipment. The three 2” Flanged Shipping Support Nozzles “S4”, “S5” and “S6” are located on the Top Head Bonnet of each filter vessel and provide support for the Internal Backpulse Gas Assembly during shipment.

Prior to Field Erection and after the Effluent Filter Vessels have been safely depressurized; then, the Special Shipping Support Nozzles should be removed and replaced with Blind Flanges. These Special Shipping Support Nozzles are easiest removed when the filter vessel is attached to the horizontal shipping support frame in the horizontal position at grade elevation.

Mott has provided six 2” spare blind flanges (2” TP304/304L SS Class 300 RFWN per B16.5) & spare gaskets for the replacement of the Special Shipping Support Flanged Fixtures. It is easier to remove and replace these Shipping Support Fixtures with blind flanges when the filter vessels are in the horizontal position. All shipping support nozzles can be removed and replaced with blind flanges from the outside of the filter vessel. Entry into the inside of the filter vessel is not required and not recommended. Each Effluent Gas Filter is a closed vessel and contains Nitrogen Gas at atmospheric pressure after depressurizing and venting. The inside of each Syngas Filter is a confined space and nitrogen gas is an asphyxiant.

5.0 Mott GSV Down-Flow Filter Vessel: Assembled For Shipment & Lift - Cont'd

Figure No. 5.3: Mott GSV Filter Vessel Special Shipping Support Fixtures (Typical)



6.0 Mott GSV Down-Flow Filter Vessel Field Erection and Installation

It is important that all internal components of each Effluent Gas Filter System remain clean and dry during all field storage, field erection, field installation, field piping, field testing and field cleaning activities by the Customer. All field installed piping connected to the Effluent Gas Filter Vessels must be clean and dry. All nozzle openings in the Effluent Gas Filter Vessels and the Accumulator Tanks should remain closed and sealed until final field piping connections are completed. The Effluent Gas Filter Vessels, Accumulator Tanks and the 6.625" OD Instrument Air Pipe Manifolds must all remain clean and dry.

The Lifting Lugs on top of each Accumulator Tank are provided to lift and remove the Filter Vessel Top Head Bonnet Assembly during Bundle Frame replacements. Refer to Figure No. 4.3 for Lift Points. The Lifting Lugs on the Top Head Bonnets of each Effluent Gas Filter Vessel are provided in order to lift each Effluent Gas Filter Vessel Assembly from the horizontal structural support frame during erection and installation. **Do Not use the Lifting Lugs on the Top of the Accumulator Tank to lift the entire Effluent Gas Filter Vessel Assembly.** Refer to Figure No. 6.1 below for filter vessel assembly Lift Points.

Figure No. 6.1: Mott GSV Filter Top Head Lifting Lugs & Shell Tailing Lug



7.0 Mott GSV Down-Flow Filter Commissioning Activities Prior to Startup

Effluent Gas Filter System Commissioning should include verification that the following mechanical and electrical work activities and appropriate safety checklists have been completed:

- Each Effluent Filter Vessel Lower J-Box (Junction Box 12-JE-1382 for Effluent Filter 12-F-13321 & Junction Box 12-JE-1482 for Effluent Filter 12-F-14321) must be field wired to each respective Mott supplied Local Control Panel (Control Panel 12-F-13321-LP for Effluent Filter 12-F-13321 & Control Panel 12-F-14321-LP for Effluent Filter 12-F-14321);
- Mott provides two communication cables (one 60 Ft. long cable for each Effluent Gas Filter) that are being installed by the Customer;
- The Customer provides and installs the conduit. The Customer installs the cable (cable pull) inside each conduit. The Customer completes field wiring terminations at each Effluent Filter Lower Junction Box and at each Mott Control Panel.
- Shipping Support Nozzles “S1” thru “S6” on each Effluent Gas Filter Vessel must be removed and replaced with 2” TP304/304L SS Class 300 RF B16.5 pre-cleaned blind flanges.

The temperature of the hydrogen gas inside the Accumulator Tanks must always be greater than the Dew Point Temperature of the Effluent Feed Gas Stream that is being filtered.

The Mott GSV Down-Flow Filtration Process utilizes surface filtration with dust cake accumulation on the outside surface of the cartridge elements. During on-line cleaning cycles, the dust cake is dislodged or removed from the outside surface of the cartridge elements by means of a sonic backpressure pulse. If the dust cake is wet or sticky; then, the dust cake release from the outside surface of cartridge elements could be incomplete during on-line cleaning cycles. Over time, this would result in the formation of a permanent solid cake on the outside surface of the cartridge elements. A permanent cake build-up would adversely affect filtration performance by decreasing Run Times, increasing backpulse gas consumption and increasing the frequency of required cartridge element change-outs.

8.0 Mott GSV Down-Flow Filter Vessel System Initial Startup

Mott has provided two local control panels 12-F-13321-LP & 12-F-14321-LP with HMI’s to monitor, control and initiate the required on-line cleaning cycles for each Effluent Gas Filter Vessel. These Mott local control panels with HMI’s will not initiate, control or monitor the feed gas flow rates through the Effluent Gas Filter Vessels. These Mott local control panels with HMI’s will not initiate, control or monitor the solids level inside the Effluent Gas Filter Vessels nor the solids discharge from the Effluent Gas Filter Vessels. The Plant Operator using the Plant DCS Operator Interface will initiate and control feed gas flow rates through the Effluent Gas Filter Vessels. The Plant Operator using the Plant DCS Operator Interface will monitor dust solids level inside the Effluent Gas Filter Vessels. The Plant Operator using the Plant DCS Operator will initiate and control solids discharge from the Effluent Gas Filter Vessels.

The Plant Operator should consult Mott Functional Specification Control Write-Up MFS-2010865 for instructions regarding Mott’s recommended Effluent Gas Filter Control Philosophy and Sequence-of-Operations.

8.0 Mott GSV Down-Flow Filter Vessel System Initial Startup - Cont'd

The Plant Operator confirms that all relevant plant commissioning and plant safety procedures and protocols are followed during the effluent gas filter system start-up. Each local control panel (Control Panel 12-F-13321-LP for Effluent Filter 12-F-13321 & Control Panel 12-F-14321-LP for Effluent Filter 12-F-14321) and the DCS Operator Interface system must be powered on.

The Plant Operator confirms that the accumulator tanks (12-D-13321 & 12-D-14321) are at an operating pressure of 80 psig (12-PT-133203 & 12-PT-143203).

The Plant Operator confirms that the 219 mm OD Instrument Air Pipe Manifolds are at an operating pressure of 80 psig.

The Plant Operator aligns process valves to and from the effluent gas filter vessels to provide flow of the process effluent feed gas stream through the filter vessel assemblies.

Each Mott supplied local control panel (12-F-13321-LP & 12-F-14321-LP) is equipped with an HMI screen for accessing operating modes, set points and displaying process variables. Refer to Mott Functional Specification & Control Write-Up MFS-2010865 for the Mott design philosophy to control On-Line Backpulse Cleaning Cycles for each Effluent Gas Filter Vessel..

Each filter default start mode is **Shutdown**. The Plant Operator selects the desired service mode (**Automatic** or **Manual** or **Purge**) at the Mott supplied local control panel HMI or at the DCS operator interface.

Each Filter “In Service” green pilot light goes on if the filter is in **Automatic** or **Manual Mode**.

Each Filter “Out of Service” red pilot light goes on if the filter is in **Shutdown Mode** or **Purge Mode**.

The Plant Operator selects the **Automatic Mode** of operation.

Each filter is “In-Service” and the control program is running. The Filter “In Service” green pilot light is on. The filter **Run Timer** is running and a constant effluent gas flow stream is being delivered to the Effluent Filter Vessel.

Dirty Effluent Gas is continuously flowing into each Effluent Gas Filter Vessel 12-F-13321 & 12-F-14321 through 10” Inlet Nozzle “A1”. Clean Effluent Gas is continuously flowing out of each Effluent Gas Filter Vessel through 10” Outlet Nozzles “B1”. Dust solids are being captured on the outside surface of the cartridge filter elements.

The filter vessel **differential pressure** slowly increases as dust solids form a filter cake on the outside surface of the cartridge filter elements. When the differential pressure or timer reaches the set point; then, an automatic cleaning cycle is initiated by the control panel PLC program.

9.0 Mott GSV Down-Flow Filter Vessel System Troubleshooting

The following Table No. 9.1 lists some common problems that may occur during operation of a typical Mott HyPulse® GSV filter. Possible causes and solutions for each problem are indicated. Further assistance may be obtained by contacting Mott Corporation at (860) 747-6333 and asking for process systems technical support.

Table No. 9.1: Troubleshooting Problems with Solutions

Problem	Possible Causes	Suggested Solution
Poor Filtered Gas Quality	Damaged or missing filter elements	Check elements for proper installation. Replace as required.
	Loose thread engagement of filter elements into tubesheet	Tighten elements on tubesheet.
	Dust solids concentration or particle size has changed	Evaluate dust solids concentration in Dirty Effluent Gas Feed Stream and check dust solids particle size distribution.
	Effluent Gas Flow Rate is too high	Decrease the Effluent Gas flow rate.
	Porous media micron grade is too large to capture fine particulate	Select filter elements more suitable for the filtration application.
Low Operating Gas Flow Rate	Process valves may be throttled or process line may be plugged	Check Effluent Gas process valves for proper alignment. Check Effluent Gas process lines for flow restrictions.
	Operating pressure drop is too high	Reduce Run Time limit or Reduce Pressure Drop limit.
High Filter Pressure Drop	Effluent Gas Flow Rate is too high	Decrease the Effluent Gas flow rate.
	High dust solids loading rate	Decrease the Run Time set point limit.
	Filter elements plugged or fouled with dust solids	Repeat cleaning cycle in Manual Mode, Reduce Pressure Drop limit, Increase Backpulse Valve Hold Time or Replace fouled elements with clean elements.
Poor Recovery Pressure Drop	Incomplete cake release during cleaning cycle	Increase Backpulse Valve Hold Time, Increase Backpulse Valve Lag Time
	Insufficient solids settling	Increase Backpulse Valve Lag Time.
	Filter elements plugged or fouled with dust solids	Repeat cleaning cycle in Manual Mode or replace fouled elements.

10.0 Mott GSV Down-Flow Filter Vessel System Trend Analysis

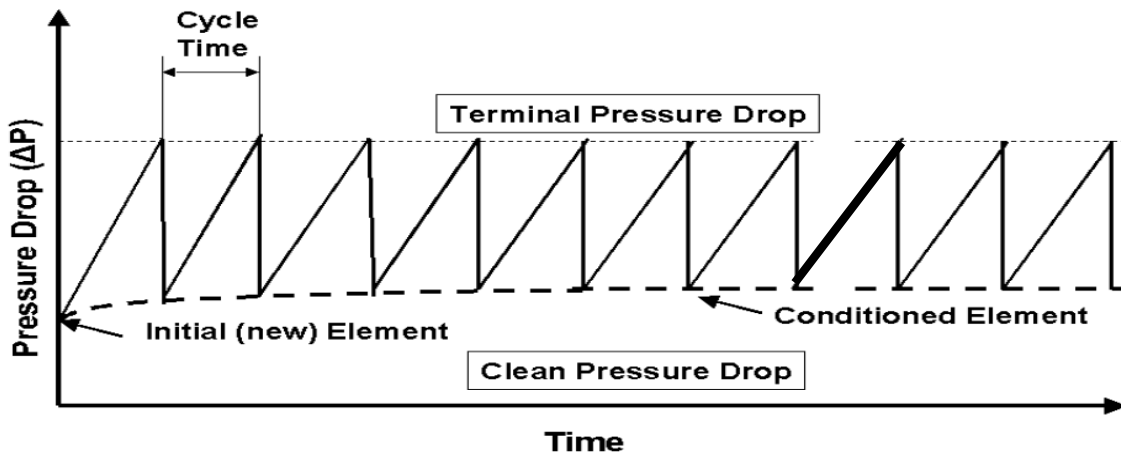
Filter data trend analysis is useful to evaluate the filter operating performance. A filter system that is functioning properly should demonstrate repeatable filtration cycle operation. A comparison of operating data from past filtration cycles with data from more recent filtration cycles will determine if the filter vessel operation is consistent.

Changes in the filter operating cycle time (Run Time) or filter differential pressure profile may be the result of variations in process operating conditions such as gas temperature, gas density, gas viscosity, dust loading, or dust particle size distribution.

An increase in the recovery pressure drop may indicate an ineffective cleaning cycle or filter element fouling.

A plot of the filter vessel pressure drop versus time should demonstrate a reproducible curve from cycle to cycle when feed gas flow rate and feed solids concentration are constant. A typical filter pressure drop vs. time graph is depicted in Graph No. 10.1 below. The plot indicates a consistent differential pressure profile and a constant recovery pressure drop over multiple filtration cycles.

Graph No. 10.1: Trending of Differential Pressure & Cleaning Cycles over Time



The filter performance may be optimized by adjusting the operating parameters and observing the effect on the filter operation.

The filtration flow rate, filtration cycle time (Run Time), filter differential pressure limit, backpulse gas pressure, backpulse valve Hold Time set point and Timer set point are all process parameters that typically are adjusted to optimize the filter system performance.

Parameters such as backpulse valve speed as determined by valve Hold Time may impact filter system performance. Backpulse Valve Hold Time & Lag Time are adjustable set points.

11.0 Mott Listing of Commercial Cleaning Vendors

Cleaning of the filter elements or filter bundle should be performed by a qualified commercial cleaning vendor. The cleaning vendor should be able to determine the best cleaning solutions and/or cleaning methods to use based upon filter service conditions and nature of the filter foulants.

The following commercial cleaning vendors are recommended by Mott Corporation:

Fil-Clean Corporation (Headquarters)
6013 Gardendale Drive
Houston, TX 77092
Phone: 713-682-3782
www.fil-cleancorporation.com

Fil-Clean Corporation
11 International Court
Greenville, SC 29607
Phone: 864-675-0017
www.fil-cleancorporation.com

Southland Technical Services, Inc.
501-#A Industrial Road
Alabaster, AL 35007
Phone: 205-685-9565: Fax: 205-685-9502
Email: techclean@bellsouth.net

Carolina Filters, Inc.
PO Box 716, 109 E. Newberry Ave.
Sumter, SC 29151
Phone: 803-773-6842: Fax: 803-755-6190
www.carolinafilters.com

Auburn/Versa-Hoe Industrial Services
PO Box 14359
Cincinnati, OH 45250
Phone: 859-428-4224: Fax: 859-428-4334
Email: results@auburn1.com

Auburn Industrial Services, LTD.
260 Fielding Road
Lively, Ontario P3Y1L6 Canada
Phone: 800-561-2285: Fax: 705-682-0888
www.auburn1.com

B&M Longworth (Edgworth) LTD.
Sett End Road, Shadsworth Industrial Estate
Blackburn, Lancashire BB1 2QG UK
Fax: +44 01254 54041
Email: enquiries@bmlongworth.com

B&ML Technology (Malaysia) SDN BHD
Block A1, Kawasan MIEL
Kawasan Perindustrian Jaya Gading Phone: +44 01254 680501
26070 Kuantan, Pahang Darul Makmur
Phone: +60 9 5677178: Fax: +60 9 5677179
www.bml.net

China National Chemical Construction Co.
No. 14 Baishan Road, Dalian City
P.R. China 116021
Phone: +86-411-84638577
Fax: +86-411-846-2611
Email: leslie.zhou@china.com

Carolina Filters, Inc.
109 E. Newberry Avenue
Sumter, SC 29150
Phone: 803-773-6842
Fax: 803-755-6190
web: www.carolinafilters.com

Precision Polymer Services Ltd.
60 Clooney Road, Londonberry
Northern Ireland
Phone: +44-2871-861600
Fax: +44-2871-861211
Web: www.pps1.co.uk

Southern Metal Processing Company
4750 W. Cedar Bayou, Lynchburg Road
Baytown, TX 77520
Phone: 281-424-3324:
Fax: 281-424-1698
Web: www.southern-metal.com